REMARKS

Claims 1-41 were pending in the application at the time of the Office Action dated July 14, 2000. Claims 42-61 were withdrawn from consideration as per restriction requirement. Claims 62-71 are added herein to recite individual or selected species of the Markush group originally presented in claims 7, 23 and 32. Accordingly claims 1-41 and 62-71 are now pending.

In the Office Action, the Examiner rejected various aspects of the invention as obvious over a combination of references, particularly Doan et al. U.S. Patent No. 5,186,670 and Gnade et al. U.S. Patent No. 5,569,058, with Gnade et al. forming the underlying ground of all the rejections under § 103. Applicants request reconsideration of this ground of rejection in light of the present Amendment and Remarks.

The disclosed embodiments of the invention will now be discussed in comparison to the prior art. Of course, the discussion of the disclosed embodiments, and the discussion of the differences between the disclosed embodiments and the prior art subject matter, do not define the scope or interpretation of any of the claims. Instead, such discussed differences merely help the Examiner appreciate important claim distinctions discussed thereafter.

The disclosure teaches at least two important contributions to the art of field emission display systems which can be embodied in many different forms. The first principle contribution is the use of porous silicon dioxide as a dielectric layer atop the conductor and substrate layer associated with the emitter element. Porous silicon dioxide, unlike ordinary silicon dioxide or polymeric "silica based" gels, is formed by oxidation of polycrystalline silicon layered on top of the substrate by various methods. By using a porous form of silicon dioxide, rather than conventional silicon dioxide or silica based gels, void pockets are formed in up to 75% of the silicon dioxide material. The formation of the voids lowers the dielectric constant of the silicon dioxide thereby decreasing the capacitance between conductive layers between which the silicon dioxide is positioned. The result of this improvement is that much less energy is required to charge the voltage of an extraction grid layer in a field emission display.

The second principle contribution is recognizing that the emitter elements of field emission displays should be formed of a material, typically a two composition material, that provides a very low work function at the emitter tip, and specifically a work function of less than 4 electron volts. When the emitter tip has a low work function and is built atop a material having high resistance, the emitter requires lower energy to operate and the electrons emitted therefrom can be better focused using less energy. The combination of the use of porous silicon dioxide with emitters having a work function of less than 4.0 electron volts is an efficient field emission display that requires substantially less power than prior art displays. In addition, the process of making such displays is more reliable and cost effective, because, the process of applying a dielectric layer having the dielectric properties of porous silicon dioxide is much easier to control than the processes of the prior art which uses agents such as polymeric silica based gels to form a porous dielectric layer.

The Examiner's characterization of the teaching of Doan et al. and Gnade et al. inaccurately reads the above two aspects of the present application into the cited art. Applicants submit these aspects are not taught or suggested in the cited references alone or in combination. More specifically, neither porous silicon dioxide nor emitter tips specifically having a work function of less than 4 electron volts are taught by the cited art. Because neither element is disclosed in the cited art, the combination of these elements is also not disclosed or suggested.

With regard to porous silicon dioxide, neither reference discloses a porous silicon dioxide layer as the dielectric in a field emission display. Doan et al. merely discloses use of ordinary silicon dioxide in a conventional manner for forming an insulative layer (*see* col 4, line 50). No mention is made of porous silicon dioxide whatsoever. This deficiency is not cured by Gnade et al. which discloses use of a silica based aerogel having a relative dielectric constant of less than 3.0 and/or use of the same in forming an insulating layer comprising a plurality of sub layers wherein adjacent sub layers differ in their relative densities (col. 1. lines 1-6).

The aerogel of Gnade et al. is not the same as a porous silicon dioxide. More specifically, the aerogel of Gnade et al., is formed by polymerizing a tetraethoxysilane precursor to form a wet gel which is then applied to the substrate assembly and dried thereon (see col. 6., line 28 to col 7, line 2). There is no pyrolysis step or other similar oxidation treatment that might conceivably convert the polymerized gel into a porous silicon dioxide but rather the polymerized product would have the structure of cross linked siloxane or silicone. Indeed, an oxidation step to convert the gelled polymer into silicon dioxide would tend to destroy the porous form created by the polymerized gel. Thus, although the aerogel structure may be "silica based" as that term in loosely used by Gnade et al., it is not porous silicon dioxide in a compositional or structural sense. In contrast, the porous silicon dioxide layer of the disclosed invention is a product formed by oxidation of poly-crystalline silicon. The structure of the product is properly a SiO_2 layer in a porous form. Therefore, it is not accurate to characterize Gnade et al. as describing a porous silicon dioxide layer because one of ordinary skill in the art would not equate the structure or composition of the porous aerogel of Gnade et al. with that of the porous silicon dioxide layer of the present invention.

Gnade et al. not only fails to disclose porous silicon dioxide, it also teaches away from use of standard silicon dioxide as a gate dielectric in field emission displays because "[a]s the thickness of the gate dielectric for flat panel displays is reduced to accommodate smaller hole diameters, the capacitive coupling present with the use of the standard SiO_2 gate dielectric increases and adversely affects proper device operation" (col. 3., lines 33-36). Because Gnade et al. teaches away from silicon dioxide generally, and both Gnade et al. and Doan et al. fail to disclose a porous silicon dioxide specifically, one of ordinary skill in the art would not have a basis to arrive at the use of porous silicon dioxide in field emission displays based on the combination of these references.

In addition, applicants submit the Examiner also incorrectly asserted that the method of making porous silicon dioxide was not germane to some of the disclosed embodiments, which include formation of the layer of porous silicon dioxide

by post anodization or post etching oxidation of polycrystalline silicon dioxide. Applicants respectfully disagree with the Examiner's opinion that the method of manufacture is not germane to patentability of porous silicon dioxide.

Porous silicon dioxide, is both a compound and a product-by-process that has structural characteristics that depend on the process of manufacture. The characteristics of the porous silicon dioxide made by etching or anodization of a polycrystalline silicon layer followed by oxidation are likely to differ from the characteristics of a porous silicon made by other techniques. For example, it is well known in the art that silicon dioxide exists in 11 or more forms that vary depending upon the method of formation and that many methods of formation are known in the art. In addition, Applicants have described at least four different aspects of a process for of forming the porous silicon dioxide on pages 5 and 6 the specification. One of ordinary skill in the art would appreciate that micro-structural characteristics of a porous silicon dioxide layer are likely to vary depending upon the exact method used to form the layer. Therefore, to the extent that porous silicon dioxide is a product-by-process that obtains distinctive structural characteristics from the process, the process of manufacture is germane to the product.

With regard to the work function of the emitter tips, Applicants respectfully submit that the Examiner has used hindsight to characterize Doan et al. as teaching or suggesting use of emitter tip materials having a work function of less than 4.0 electron volts. Doan et al. says nothing about work functions in that range but merely discloses a list of low function emitter tip materials at col. 6, lines 29-32. Applicants request the Examiner to note Table E-81 from the *CRC Handbook of Physics and Chemistry,* 54th Edition, and Table 10.10 from *Semiconductor Integrated Circuit Processing Technology*, Addison-Wesley Publishing (1990) each submitted herewith. These tables show that of the 11 materials mentioned by Doan et al. only one (barium) clearly has a work function of less than 4.0 electron volts. Four compounds, cermet, titanium carbide, titanium nitride and chromium silicide are not listed. However, these tables show that the majority of the materials mentioned in Doan et al. have higher work functions than 4.0. Because most of the materials in

Doan et al. have work functions greater than 4.0, one of ordinary skill in the art would not find a suggestion, or be motivated by the list provided in Doan et al. to use materials with a work function of less than 4.0 electron volts merely because, in retrospect, one out of eleven (or at most four) materials mentioned in that reference might have a work function in that range.

In contrast, Applicants' invention specifically includes a list of suitable materials (i.e., Table I of the specification) that are selected for having a work function of 4.0 or less. Part of Applicants' invention is in recognizing the utility of this work function range specifically for use in emitter tips for field emission displays. Of the materials recited in Table I, the majority are not part of the list provided by Doan et al. Thus, the particular element of having a work function of less than 4.0 is not suggested by Doan et al. Moreover, there is no suggestion to combine these types of emitter tips with a porous silicon dioxide layer.

It is well established that for an invention to be obvious over a combination of references, there must me some teaching in the references that would suggest or motivate one of ordinary skill in the art to make or use the invention with an expectation of success. In light of the above, Applicants respectfully submit that the cited art fails to provide the requisite suggestion or motivation in the present case.

Claim Rejections Under § 103

Turning now to the claims, the Examiner rejected claims 1-7, 10-23 and 26-32 as obvious over Done et al. in view of Gnade et al.

Claims 8 and 24 were rejected over the above two references further in view of Jones et al., U.S. Patent No. 5,869,169.

Claims 9, 25 and 33 were rejected over the above three references further in view of Itoh et al., U.S. Patent No. 5,793,154.

Claims 34-28 were rejected over Gnade et al. further in view of Thoeny et al., U.S. Patent No. 5,473,222.

Claims 1, 10, 16, 26 and 34 were independent claims. Of these, claims 1, 10, and 26 were said to recite essentially the same elements and were rejected for

identical reasons. In addition, claims 7, 23 and 32 which recite a Markush group that includes two materials disclosed in Doan et al. were also rejected for identical reasons.

Applicants traverse these grounds of rejection.

Claim 1 recites a field emission display comprising in pertinent part, "a porous silicon dioxide dielectric layer formed on the substrate and the conductors" and refers to a emitter tips "having a work function or electron affinity of less than 4 electron volts."

Claim 10 recites another embodiment of a field emission display having a porous silicon dioxide layer, including among other aspects, where the porous silicon dioxide layer is formed by anodization.

Claim 16 recites still another embodiment of a field emission display having a porous silicon dioxide layer, including among other aspects, where the porous silicon dioxide layer is formed by modification of a silicon layer.

Claim 26 recites still another embodiment of a field emission display having a porous silicon dioxide layer, including among other aspects, where the porous silicon dioxide layer is formed by oxidation of porous silicon.

Claim 34 recites a computer system including various components including among other things, a display that includes porous silicon dioxide layer.

As mentioned above, neither Doan *et. al.* or Gnade et al., suggest a porous silicon dioxide layer or emitter tips having a work function of less than 4 electron volts.

Moreover, because Gnade et al. does not suggest a porous silicon dioxide layer, the combination of that reference with Thoeny et al. does not suggest the elements of claim 34.

With regard to the Markush group recited in claims 7, 23 and 32, Applicants submit that as written, these claims further limit the above allowable base claims. As mentioned above, most of the species recited in the Markush group are not taught or suggested by the cited art. Moreover, solely to cover certain specific embodiments of the invention, Applicants have added new claims 62-71 recite

individual subspecies from the Markush groups and exclude barium. None of the species recited in new claims 62-71 are disclosed in the cited art.

Applicants believe that the various dependent claims of the invention are patentable over the cited art on separate grounds in addition to being patentable by further limiting an allowable base claim. In the interest of brevity, Applicants do not further distinguish each dependent claims over those references in the instant response. Applicants do not however, admit or imply that the dependent claims rise and fall with the patentability of the independent claims

Objection to the Title

The Examiner indicated that the title should be changed to be more descriptive of the invention. Applicants thank the Examiner for the suggestion and has amended the title accordingly.

Claim Objections, and Rejections Under Section 112

Claim 15, was objected to because of lack of a wherein statement, after the reference to the independent claim 10. Claims 1, 10, 34 and their respective dependent claims were rejected under § 112, second paragraph, for lack of clarity or lack of antecedent basis.

Applicants thank the Examiner for noting these errors and has amended these claims accordingly. Claim 1, now makes it clear that the dielectric layer is porous silicon dioxide, claim 10 provides antecedent basis for "the dielectric layer", claim 15 now has a wherein clause, and claim 34 has been amended to change "the columns." To 'the conductor" which has antecedent support originally intended by Applicants.

Applicants submit that all of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited. The Examiner is urged to contact the undersigned attorney by telephone if any questions or resolved formalities remain.

Respectfully submitted,

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